HEMOSTASIS-DIRECTED RESUSCITATION IN TRAUMA

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http://www.youtube.com/watch?v=-_6vGj67Iq8

Severe Trauma Scenarios

- 20 year old marine on patrol sustains multiple penetrating shrapnel wounds to abdomen and proximal amputation of left arm from an IED blast. VSS: BP 100/50, GCS 13
- 42 year old female extricated from her vehicle after roll over. She has blunt trauma injuries to the abdomen and chest. VSS: 95/35, GCS 9
- How would you resuscitate?

Information

- Worldwide, injury is responsible for more than 5 million deaths per year.
- Uncontrolled hemorrhage is the leading cause of potentially preventable death after trauma.
- Traditionally(ATLS, ED protocols), pts were serially resuscitated with large volumes of crystalloid and/or colloids and RBC’s- followed by smaller amounts of plasma and plts.
- Transfusion data: from the ongoing wars and from multiple civilian studies now question this tradition-based practice.

Historical Background

- Over last 40 yrs., transfusion therapy evolved from use of predominately whole blood to now largely component therapy.
- Whole blood: still used in many developing countries and in military situations, however
- Component therapy predominates primarily due to resource utilization and safety.
- Change occurred without strong evidence of clinical outcomes between whole blood and component therapy in MT patients.
- WWI & WWII: plasma and whole blood
- Vietnam: aggressive crystalloids-wrongly ascribed to the teachings of Carrico and Shires- balanced resuscitation

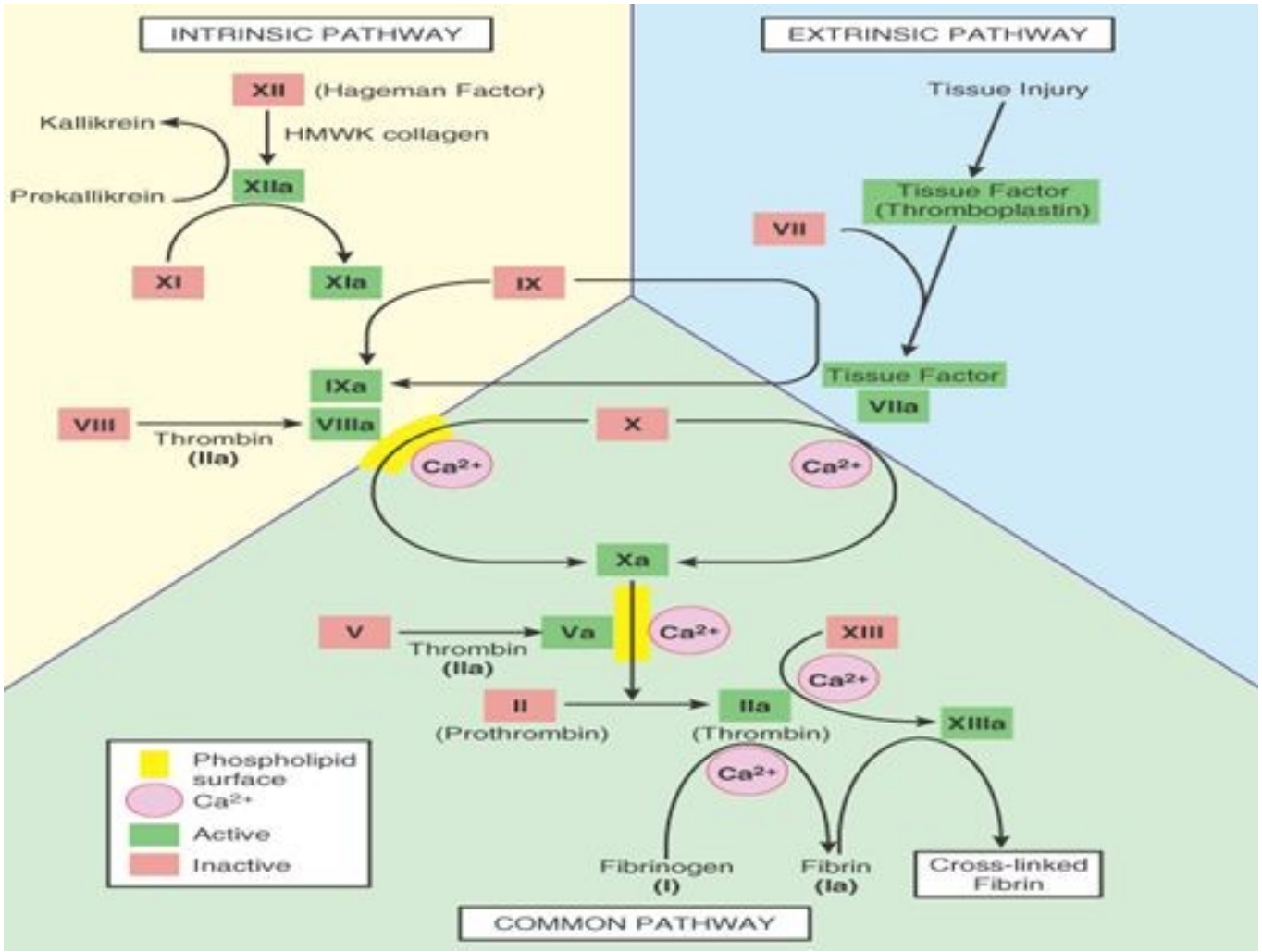
Acute Coagulopathy of Trauma

- ~¼ of severely injured trauma pts at ER admission are **coagulopathic**.
- Not well understand however speculated to be:
- As a result of tissue hypo perfusion-> release of inflammatory mediators.
- **Acidosis:** anaerobic metabolism
- **Hypothermia**-> platelet dysfunction, inhibits coag pathway enzymes
- "Lethal Triad": **coagulopathy, hypothermia and acidosis**(Bloody Vicious Cycle)-often cannot be reversed

Con’t

- Current teaching: avoid reaching these conditions using conventional damage control surgery.
- Focuses on reversing acidosis, preventing hypothermia and surgically controlling hemorrhage.
- **Neglects Coagulopathy**-viewed as byproduct of resuscitation, hemodilution and hypothermia
- Advocates massive transfusion using unbalanced components(PRBC’s, crystalloids and hemostatic factors)-> coagulopathy

Coagulation Cascade

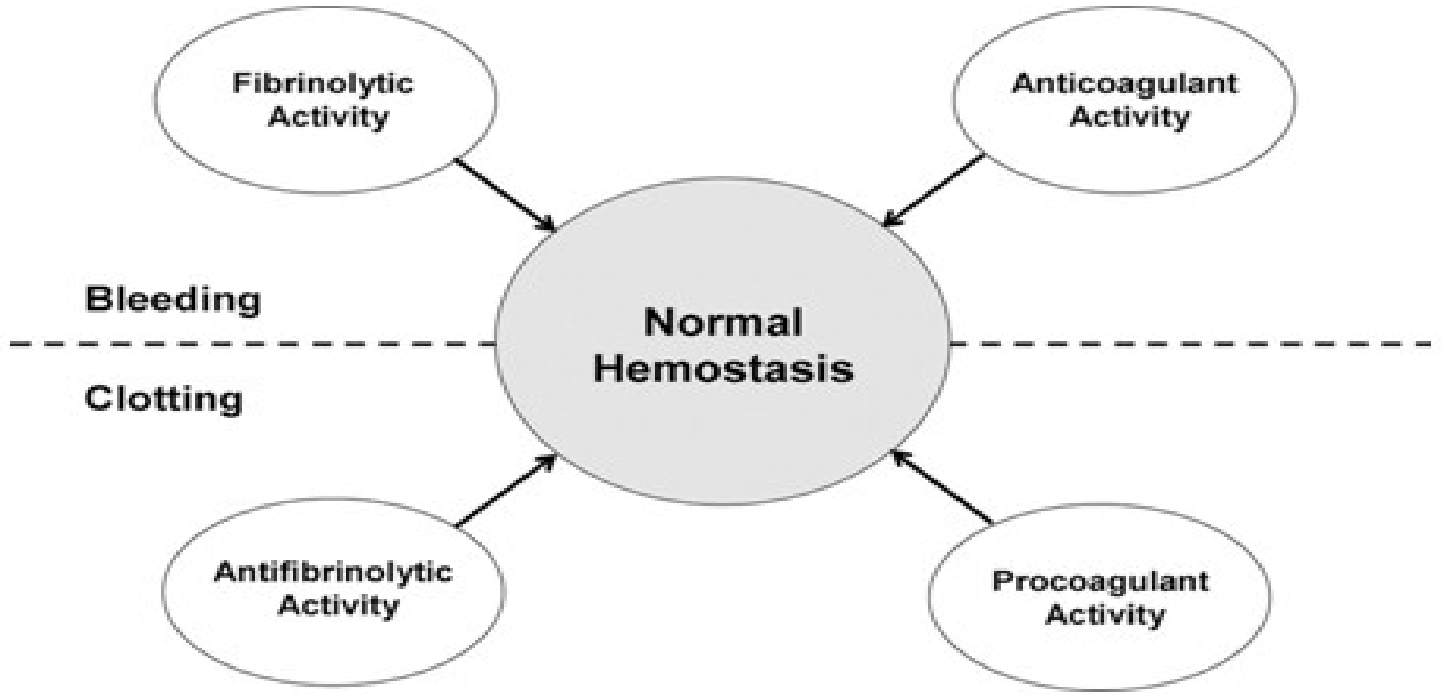


Coagulation: simplified?

- Tissue Factor (thromboplasmin), released by tissue injury, forms a complex with FVIIa
- Activation of FXa directly
- Activation of FIXa, which forms a complex with FVIIIa and phospholipid
- FXa forms a complex with FVa and phospholipid to convert prothrombin to thrombin, which converts fibrinogen to fibrin

Normal Hemostasis

Figure 1. Normal hemostasis is a result of interaction among physiologic systems that promote bleeding (anticoagulant and fibrinolytic) or clotting (procoagulant and antifibrinolytic).



Levy J H et al. Anesth Analg 2010;110:354-364

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Damage Control Resuscitation(DCR)

- Based on new data from combat casualties and multidisciplinary opinions regarding optimal resuscitation for hemorrhagic shock.
- DCR targets the entire **lethal triad**
- "**Balanced Strategy**"- emphasizes:
- Early, and increased use of FFP, Plts and RBC(1:1:1)- **Current US military resuscitation practice**
- Minimizes crystalloid use-only as carrier fluid for blood products
- **Hypotensive Resuscitation Strategies**-titrating fluid resuscitation to a lower than nl SBP prior to definitive hemorrhage control.

DCR con’t

- Use adjuncts: Ca++, THAM(tris-hydroxymethyl aminomethane), rFVIIa(recombinant clotting factor VII)
- Early definitive hemorrhage control: **pre-hospital, ER, OR**
- Civilian sector- proven survival benefits with protocol

http://www.youtube.com/watch?v=e9xvIbKBJn4

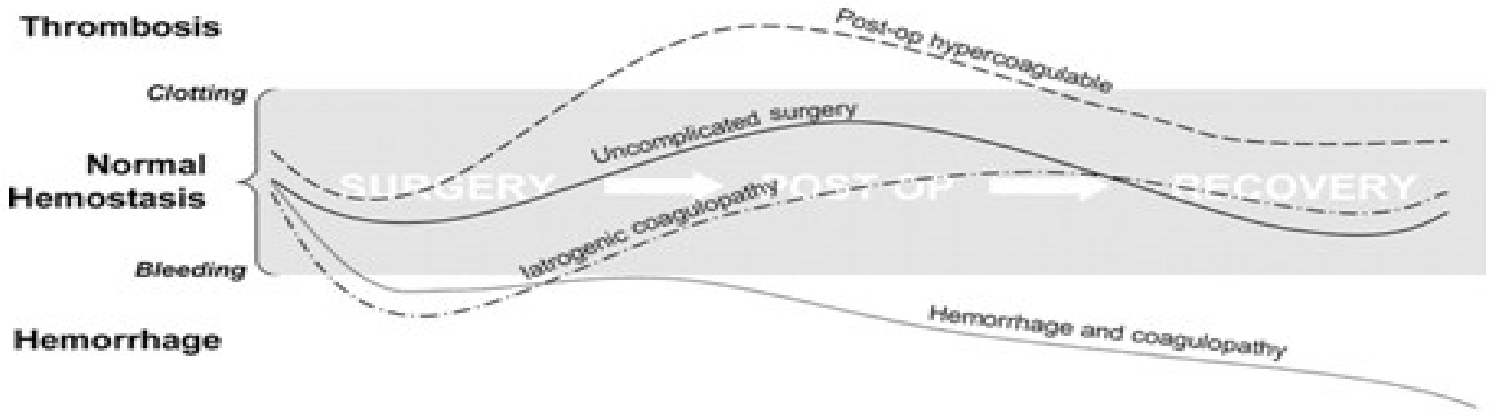
http://www.youtube.com/watch?v=cgu8PtRDY2c&feature=bf_prev&list=UUTyK5AJ65IO6niHjkU3tGNg

Challenges

- Increased use of Plasma, Cryo and Plts-> significant stress on blood banking system.
- Logistically challenged system or remote/austere military-> will fail without good solutions.
- Transfusing the exact product required in goal directed approach-> require rapid, accurate and validated coagulation tests.

Risks associated with transfusion

Figure 2. Examples of thrombosis and hemorrhage risks associated with surgery.



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Solutions/Future Products/Transfusion Concepts

- **Walking blood bank** -> fresh whole blood transfusion
- Large volume:500ml/unit
- Type specific
- Rapid: less 30mins to the 1st unit with well trained staff
- All Coags factors, RBC's and Plts
- Less 1% chance contracting blood borne dz- military members pre-screened prior to deployment.
- **Military research ongoing**- reverse engineering fresh whole blood.
- Small, lightweight, ambient temp storage of **dried blood products**-> monetary and logistical benefits

Solutions/Future Products/Transfusion Concepts- cont'd

- Thrombpelastometry- Rapid point of care testing of whole blood-superior to traditional INR, PT and PTT
- Evaluates overall hemostatic status- platelets function as well as fibrinolysis
- ROTEM, Sonoclot

http://www.youtube.com/watch?v=W_y-g1Gjd5M

Sonoclot or ROTEM

Questions?